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(54) **SOFTWARE TOOL FOR DERIVING COLORS FROM A REFERENCE COLOR BY VARYING COLOR CHARACTERISTICS**

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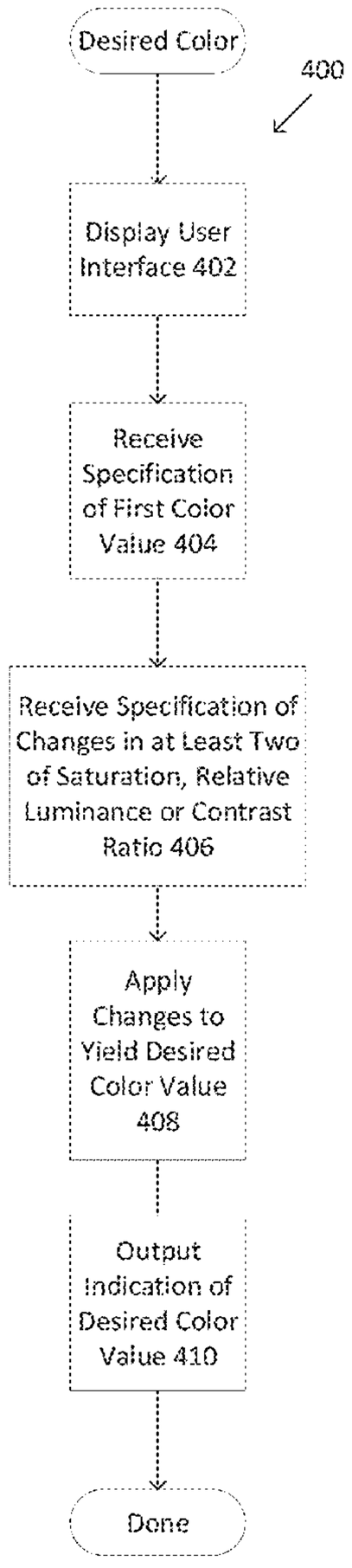
(57) **ABSTRACT**

The exemplary embodiments may provide a software tool that enables a software designer to derive a color from a reference color. The software designer may specify changes in color characteristics that are to be applied to the reference color to derive the desired color. The user interface may be provided to allow the software designer to enter information regarding the reference color and the desired changes in color characteristics. The user interface may display the reference color and that resulting desired color so that the software designer may get a visual appreciation for the difference in the colors. The software tool of the exemplary embodiments may also include a color palette generator. The color palette generator may generate a palette of colors from a reference color.



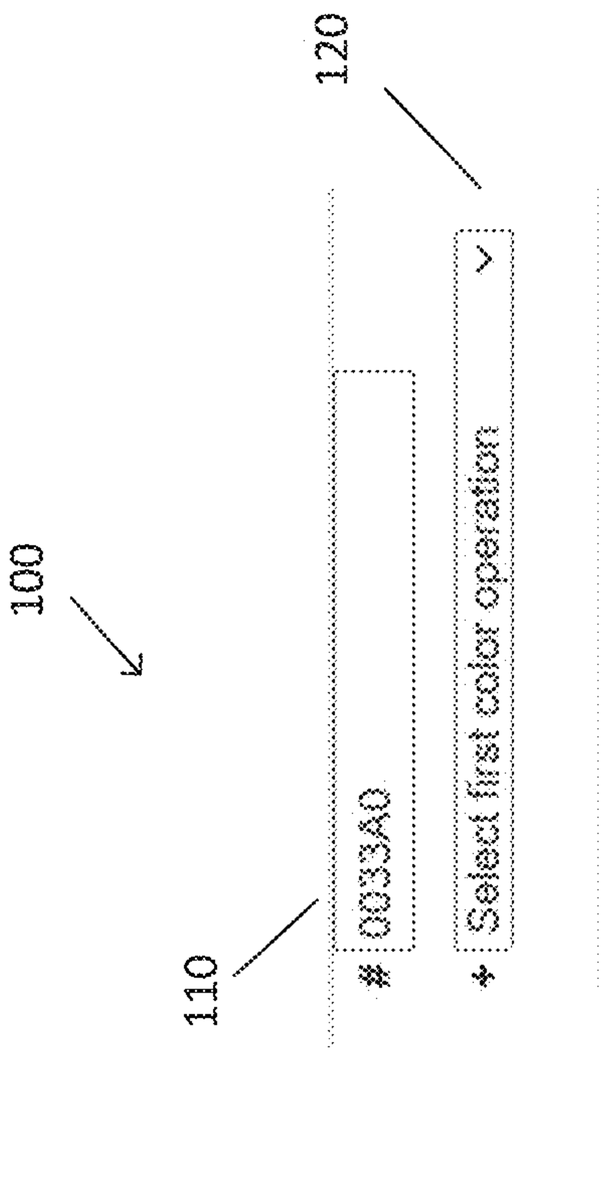


Figure 1A

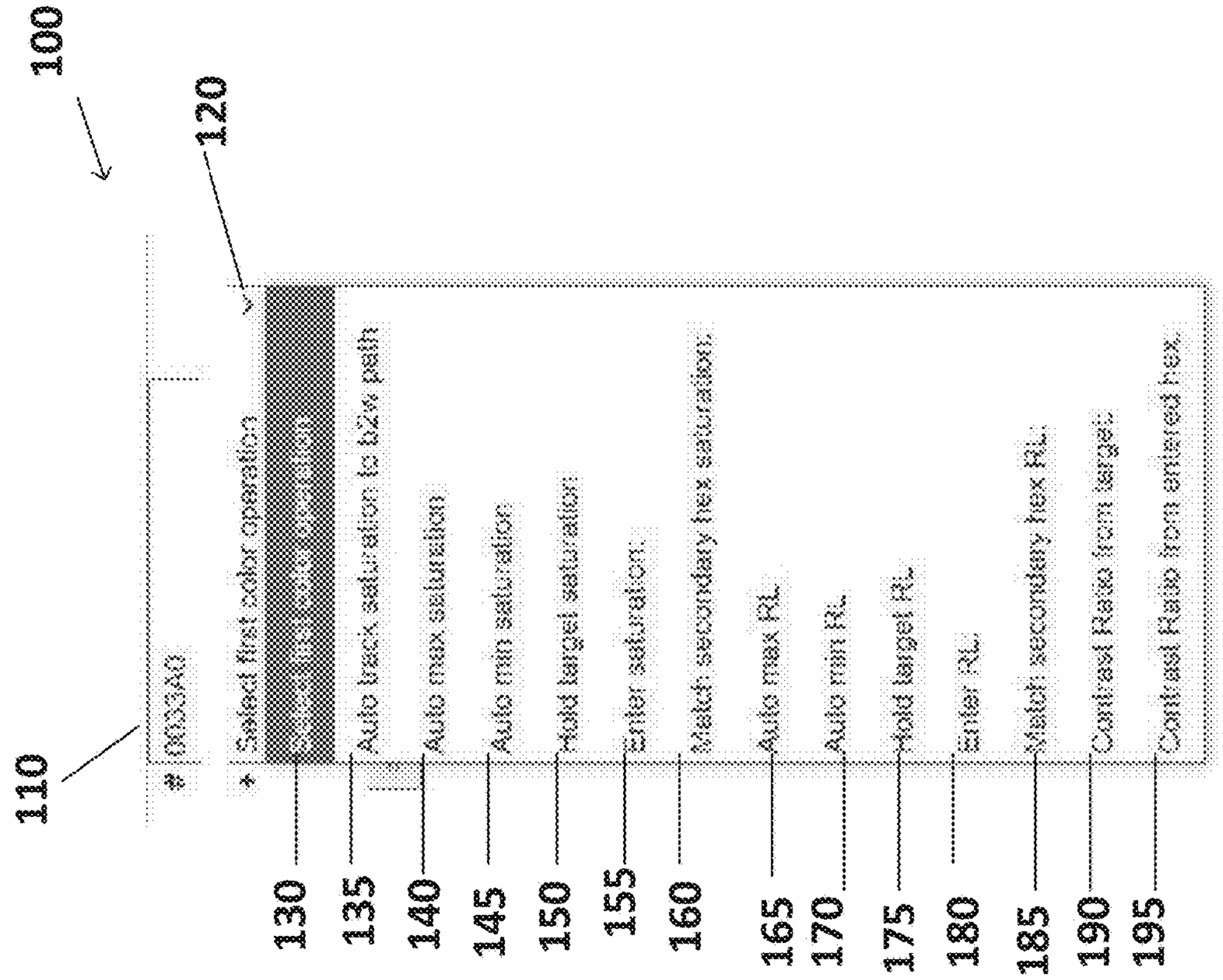

100
110
120
003A0
* Select first color operation
Color operation selection
Auto track saturation to b2% path
Auto max saturation
Auto min saturation
Hold target saturation
Enter saturation
Match secondary hex saturation
Auto max RL
Auto min RL
Hold target RL
Enter RL
Match secondary hex RL
Contrast Ratio from target:
Contrast Ratio from entered hex
130
135
140
145
150
155
160
165
170
175
180
185
190
195

Figure 1B

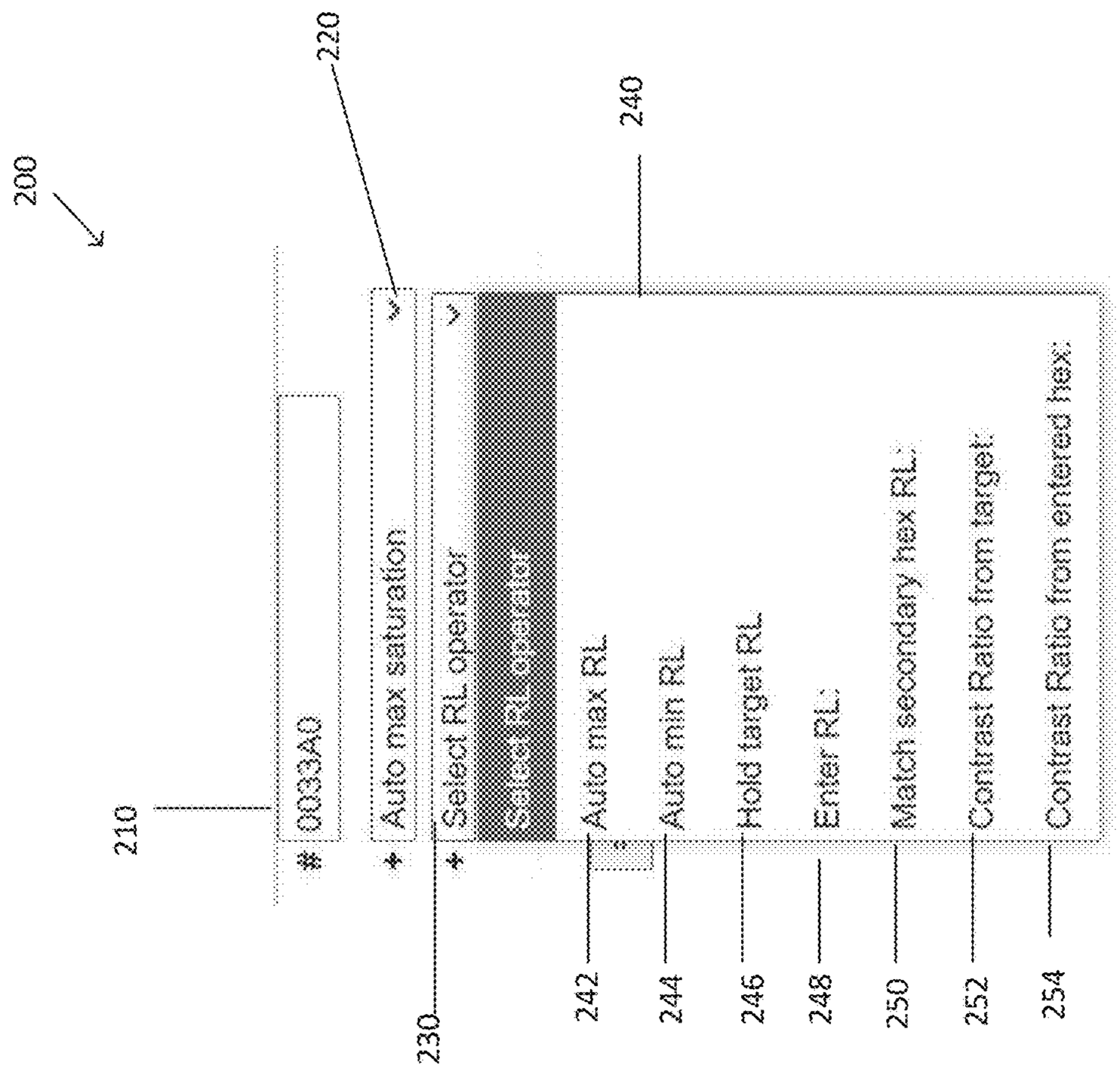

200
210
220
240
230
0033A0
Auto max saturation
Select RL operator
Select RL operator
Auto max RL
Auto min RL
Hold target RL
Enter RL:
Match secondary hex RL:
Contrast Ratio from target:
Contrast Ratio from entered hex:
242
244
246
248
250
252
254

Figure 2A

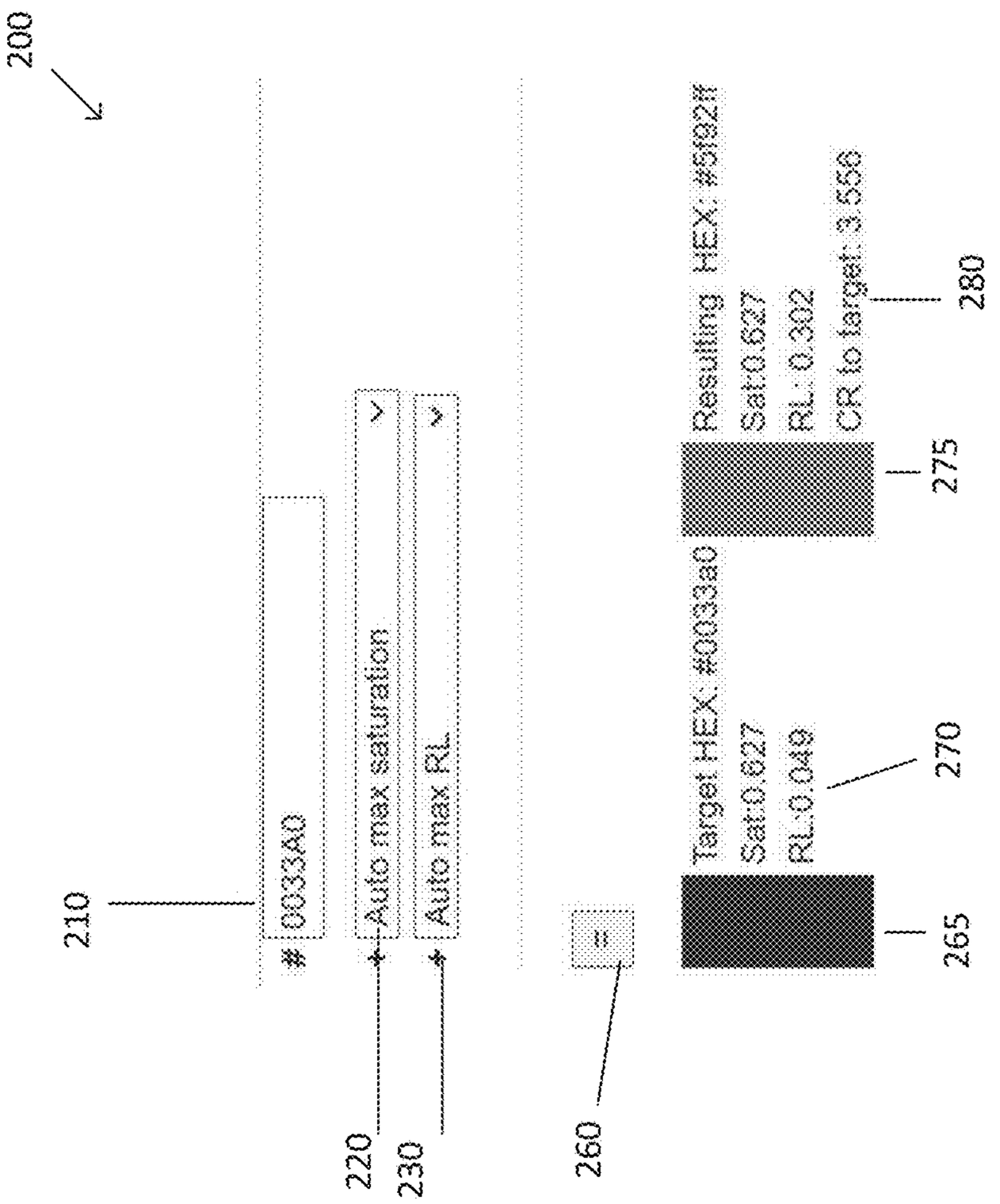

200
210
0033A0
Auto max saturation
Auto max RL
=
220
230
260
Target HEX: #0033a0
Sat:0.627
RL:0.049
265
270
Resulting HEX: #6f
Sat:0.627
RL: 0.302
CR to target: 3.556
275
280

Figure 2B

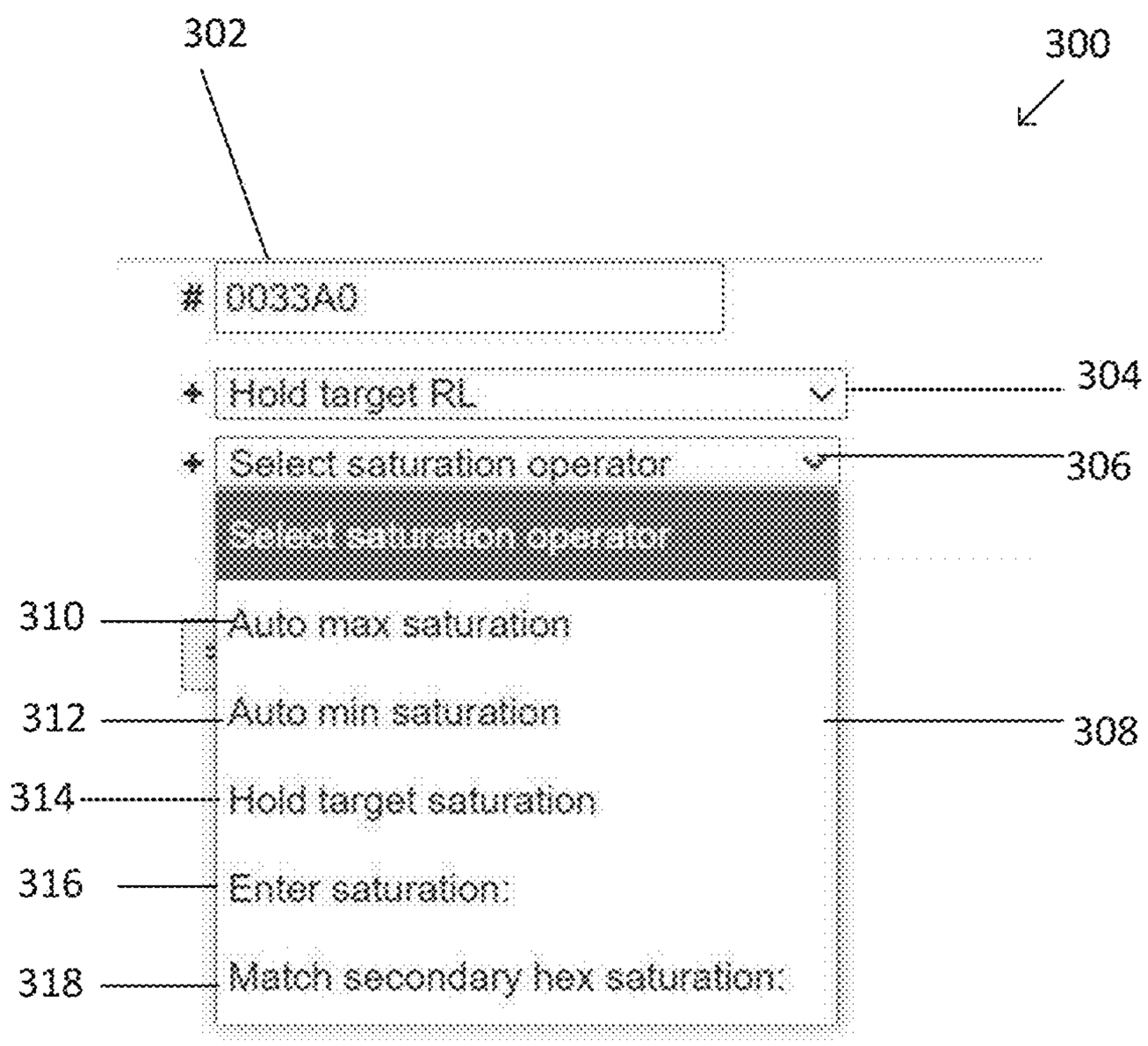

302
300
0033A0
Hold target RL
304
Select saturation operator
306
Select saturation operator
310
Auto max saturation
312
Auto min saturation
308
314
Hold target saturation
316
Enter saturation:
318
Match secondary hex saturation:

Figure 3

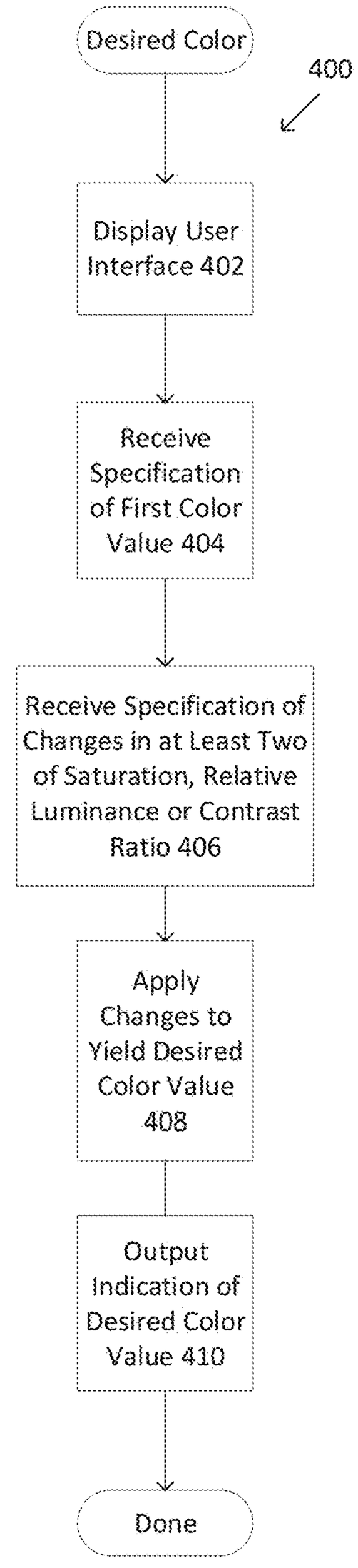

Desired Color
400
Display User Interface 402
Receive Specification of First Color Value 404
Receive Specification of Changes in at Least Two of Saturation, Relative Luminance or Contrast Ratio 406
Apply Changes to Yield Desired Color Value 408
Output Indication of Desired Color Value 410
Done

Figure 4

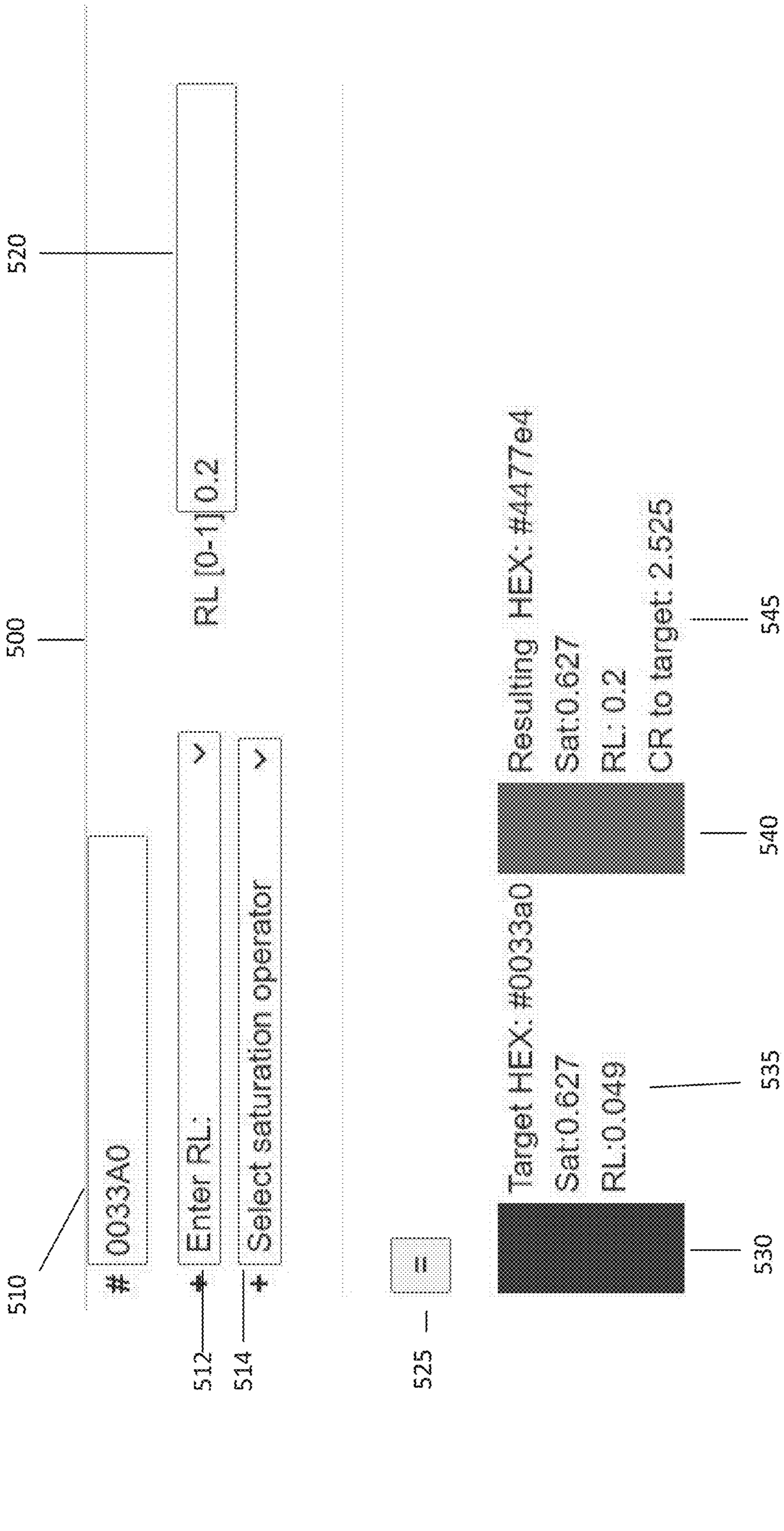

500
510
520
0033A0
Enter RL:
RL [0-1] 0.2
Select saturation operator
+
512
514
=
525
Target HEX: #0033a0
Sat:0.627
RL:0.049
530
535
Resulting HEX: #4477e4
Sat:0.627
RL: 0.2
CR to target: 2.525
540
545

Figure 5

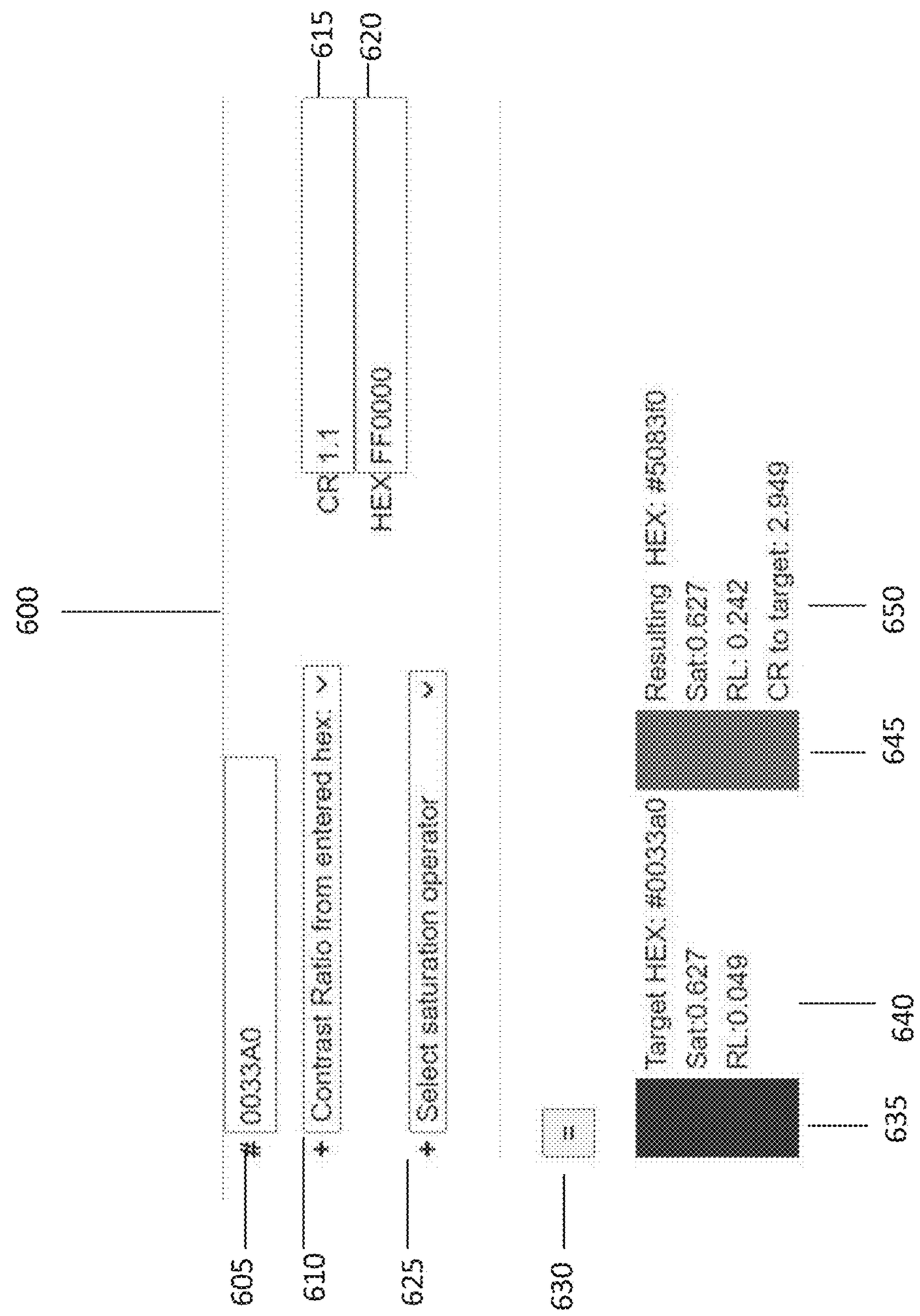

600
605
0033A0
610
Contrast Ratio from entered hex >
625
Select saturation operator >
630
=
615
620
CR 1.1
HEX FF0000
635
Target HEX: #003ea0
Sat:0.627
RL: 0.049
640
645
Resulting HEX: #5083f0
Sat:0.627
RL: 0.242
CR to target: 2.949
650

Figure 6

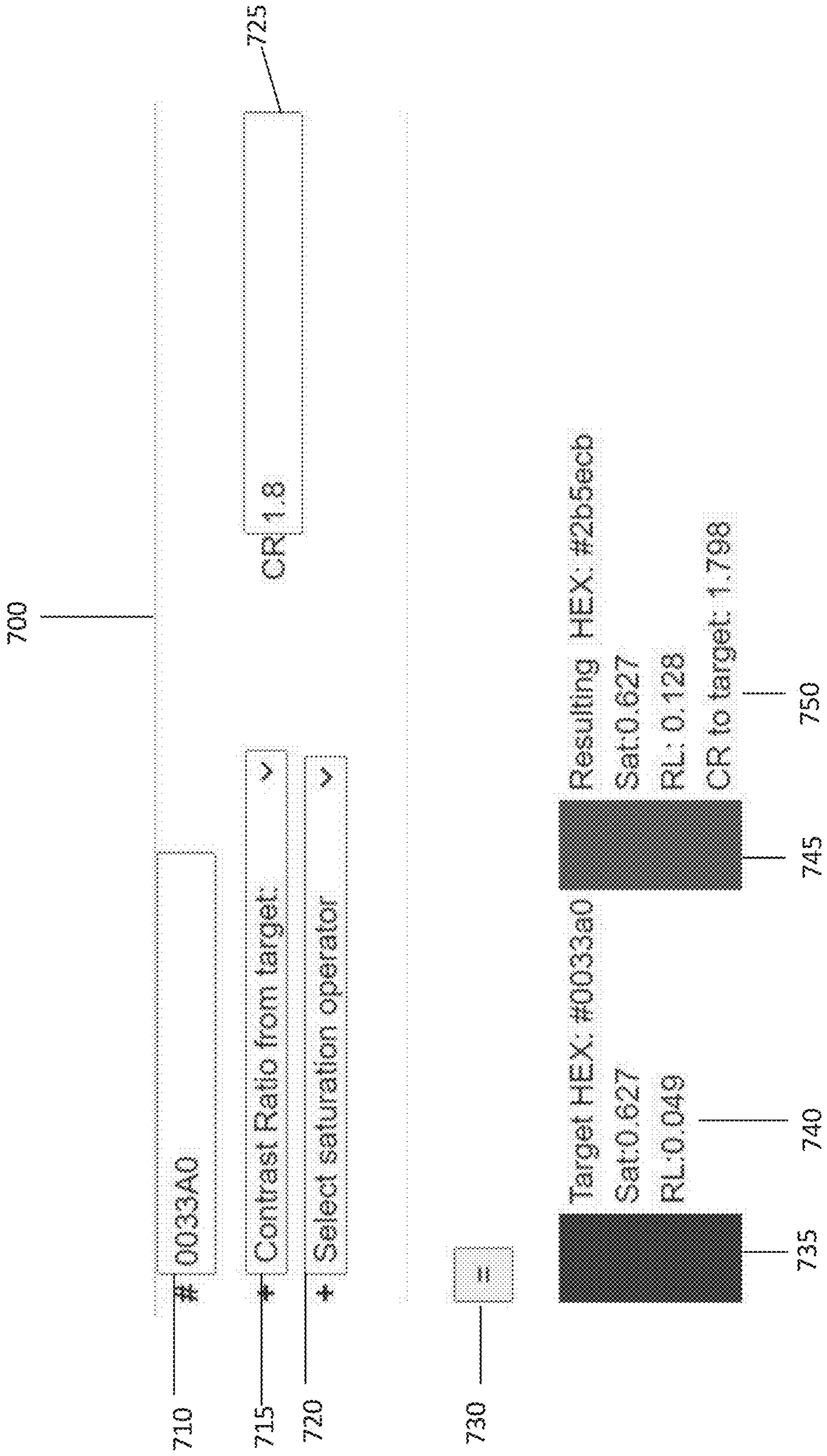

700
725
CR 1.8
710
#0033A0
715
Contrast Ratio from t
720
Select saturation ope
730
=
Resulting HEX: #2b5ecb
Sat:0.627
RL: 0.128
CR to target: 1.798
750
745
Target HEX: #00
Sat:0.627
RL:0.049
740
735

Figure 7

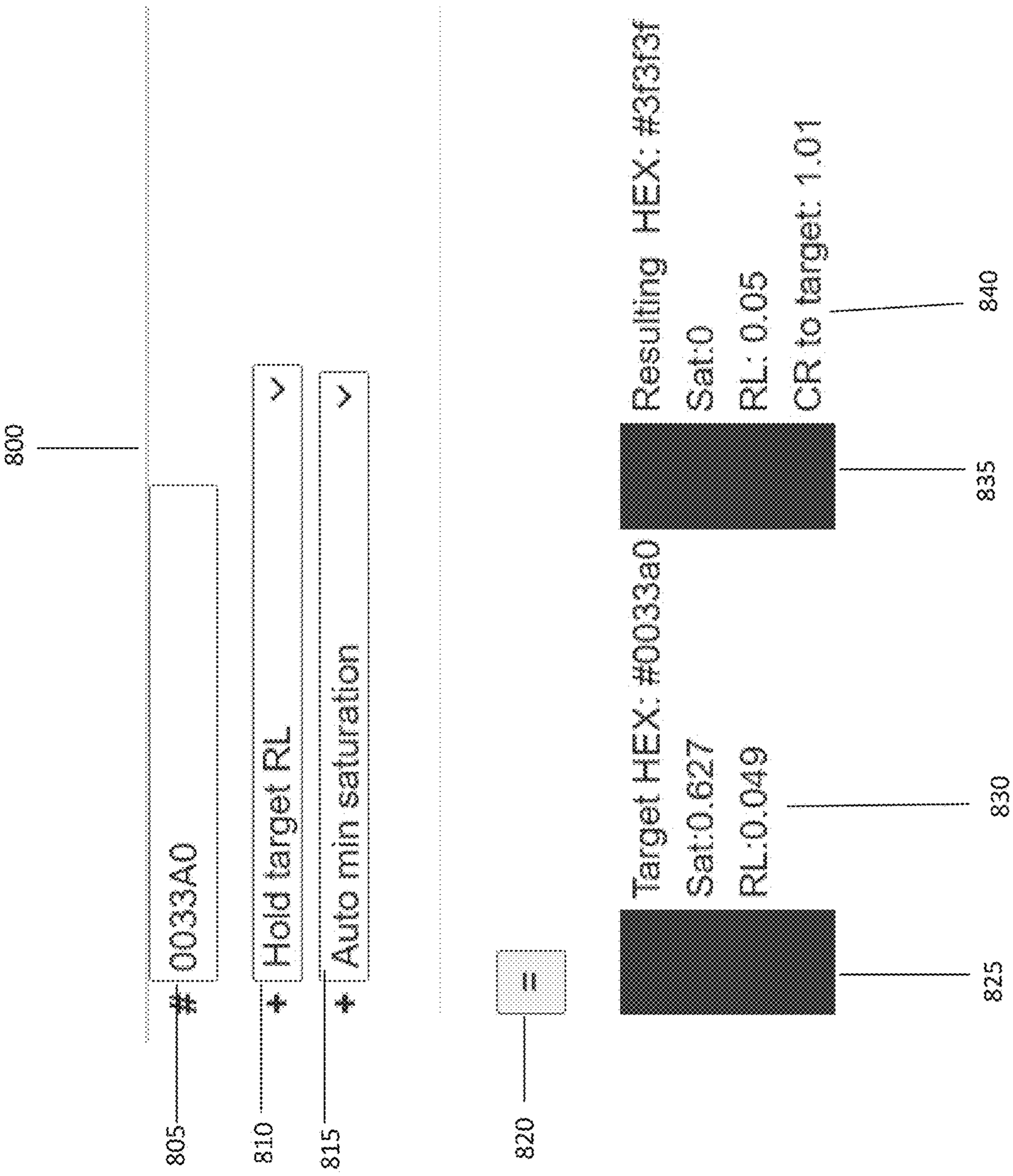

800
0033A0
+ Hold target RL
+ Auto min saturation
=
Target HEX: #0033a0
Sat:0.627
RL:0.049
Resulting HEX: #3f3f3f
Sat:0
RL: 0.05
CR to target: 1.01
805
810
815
820
825
830
835
840

Figure 8

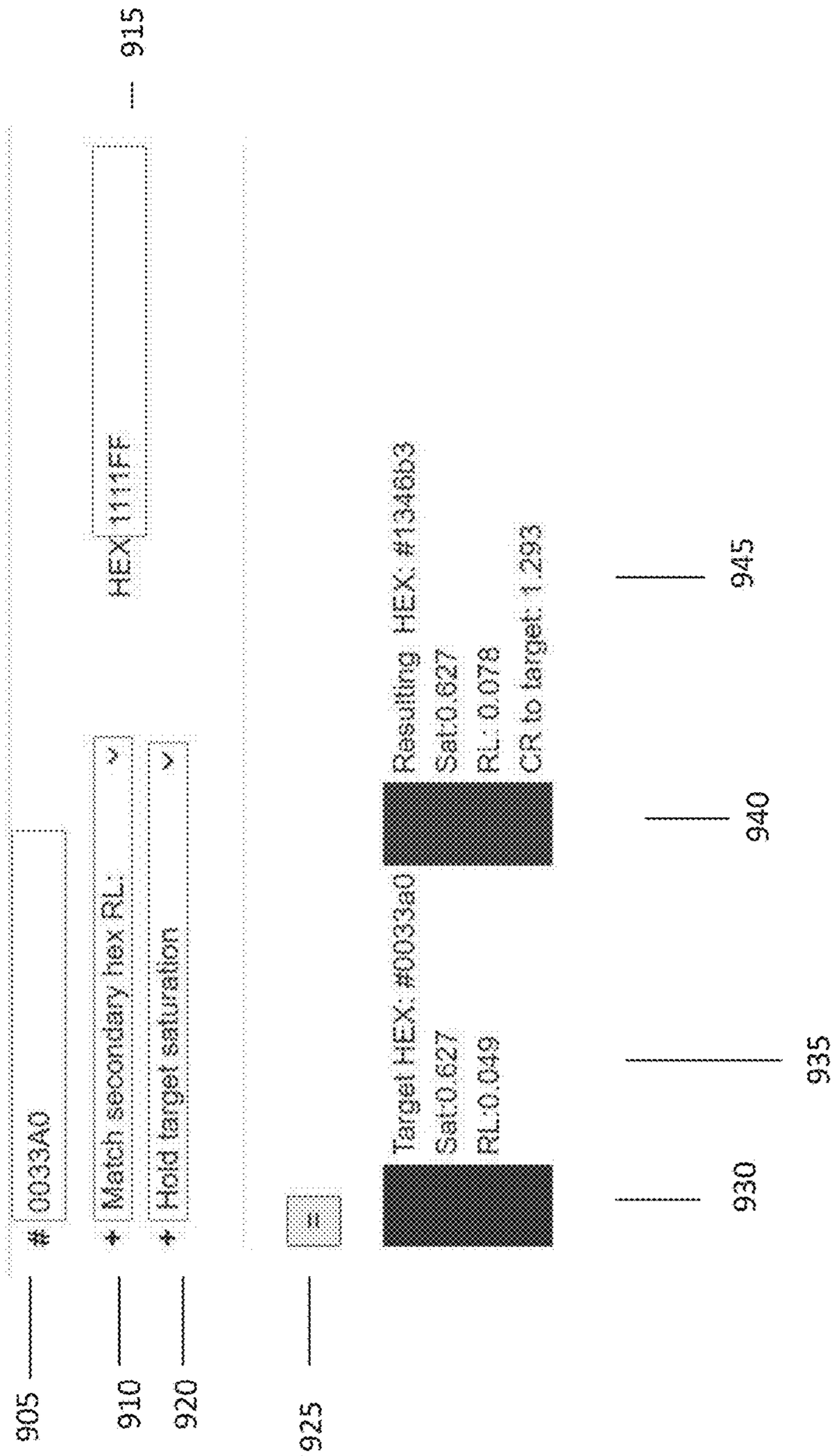

900
905
0033A0
910
Match secondary hex RL
915
HEX 1111FF
920
Hold target saturation
925
=
930
Target HEX: #0033a0
Sat:0.627
RL: 0.049
935
940
Resulting HEX: #1346b3
Sat:0.627
RL: 0.078
945
CR to target: 1.293

Figure 9

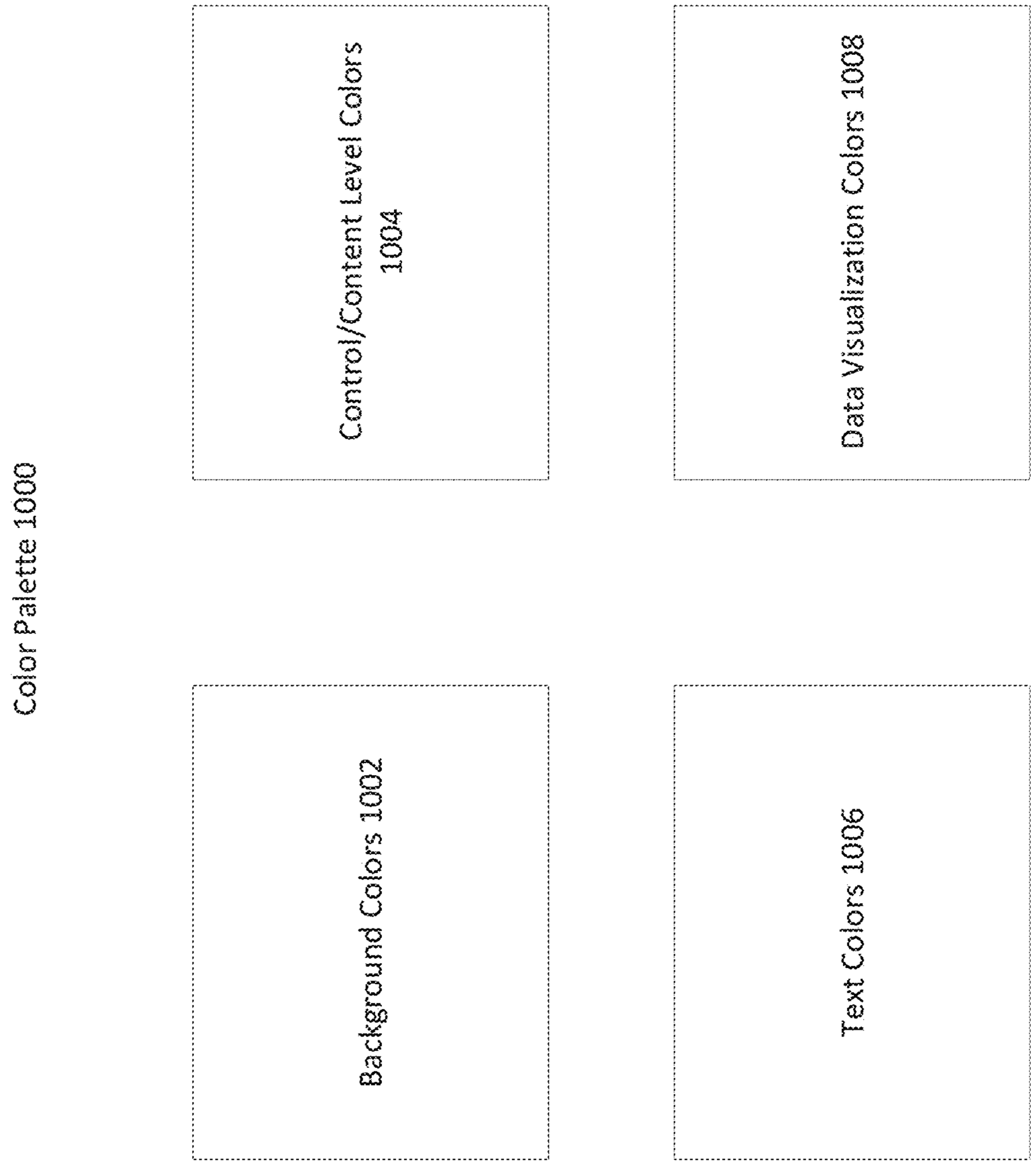

Color Palette 1000
Control/Content Level Colors 1004
Data Visualization Colors 1008
Background Colors 1002
Text Colors 1006

Figure 10

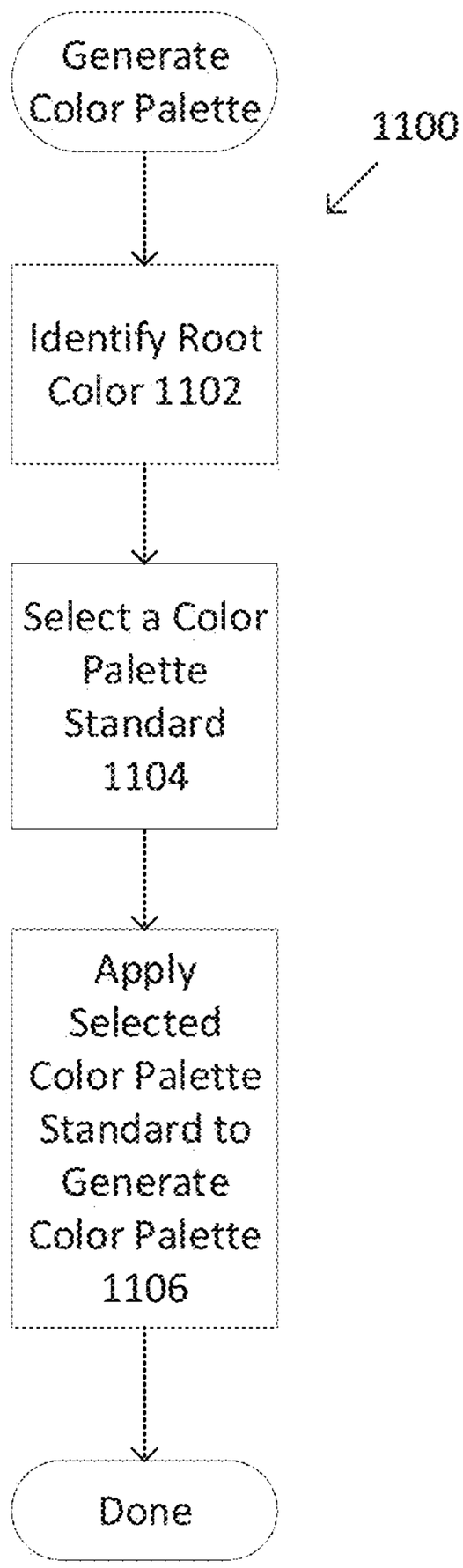

Generate Color Palette
1100
Identify Root Color 1102
Select a Color Palette Standard 1104
Apply Selected Color Palette Standard to Generate Color Palette 1106
Done

Figure 11A

Low Lighting Color Palette 1120
Medium Lighting Color Palette 1122
Bright Lighting Color Palette 1124

Figure 11B

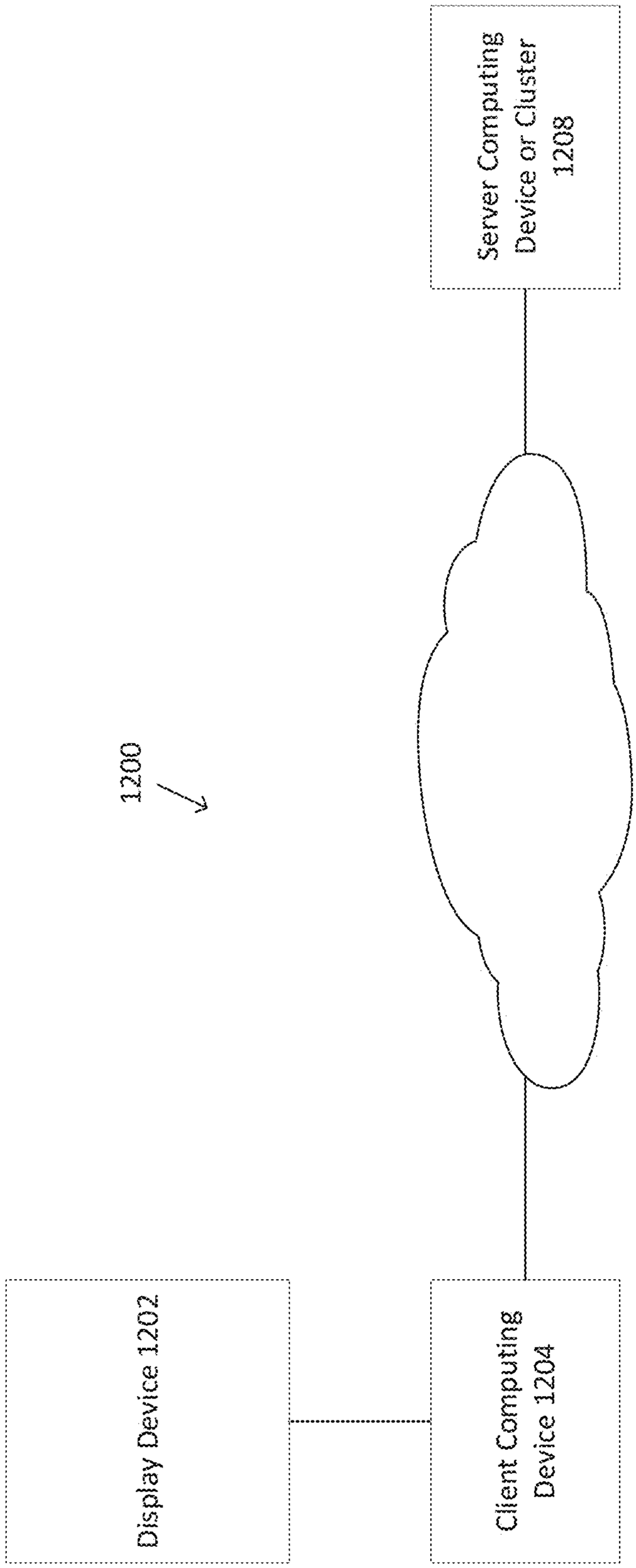

Server Computing Device or Cluster 1208
Network 1206
1200
Display Device 1202
Client Computing Device 1204

Figure 12

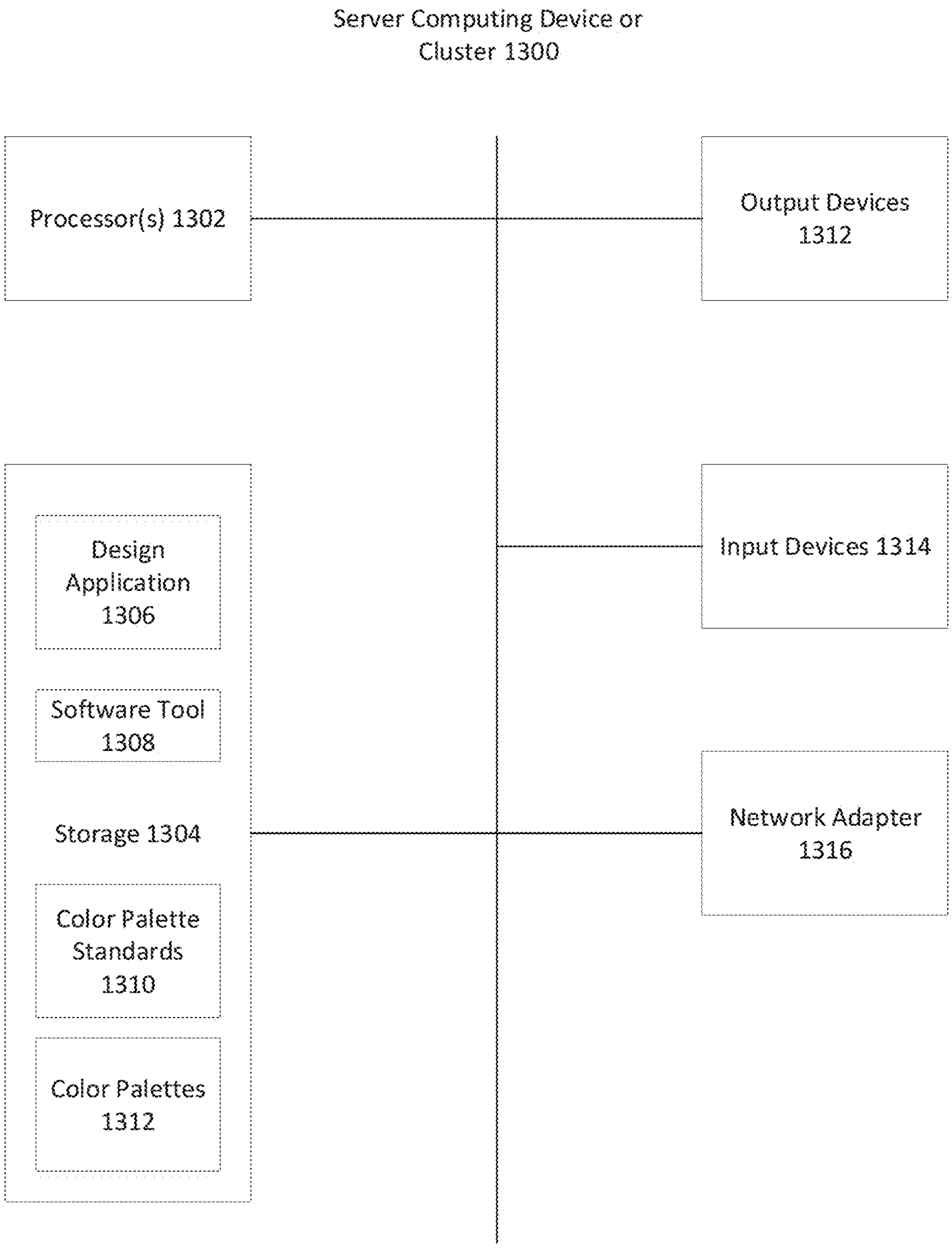

Server Computing Device or Cluster 1300
Processor(s) 1302
Output Devices 1312
Input Devices 1314
Network Adapter 1316
Design Application 1306
Software Tool 1308
Storage 1304
Color Palette Standards 1310
Color Palettes 1312

Figure 13

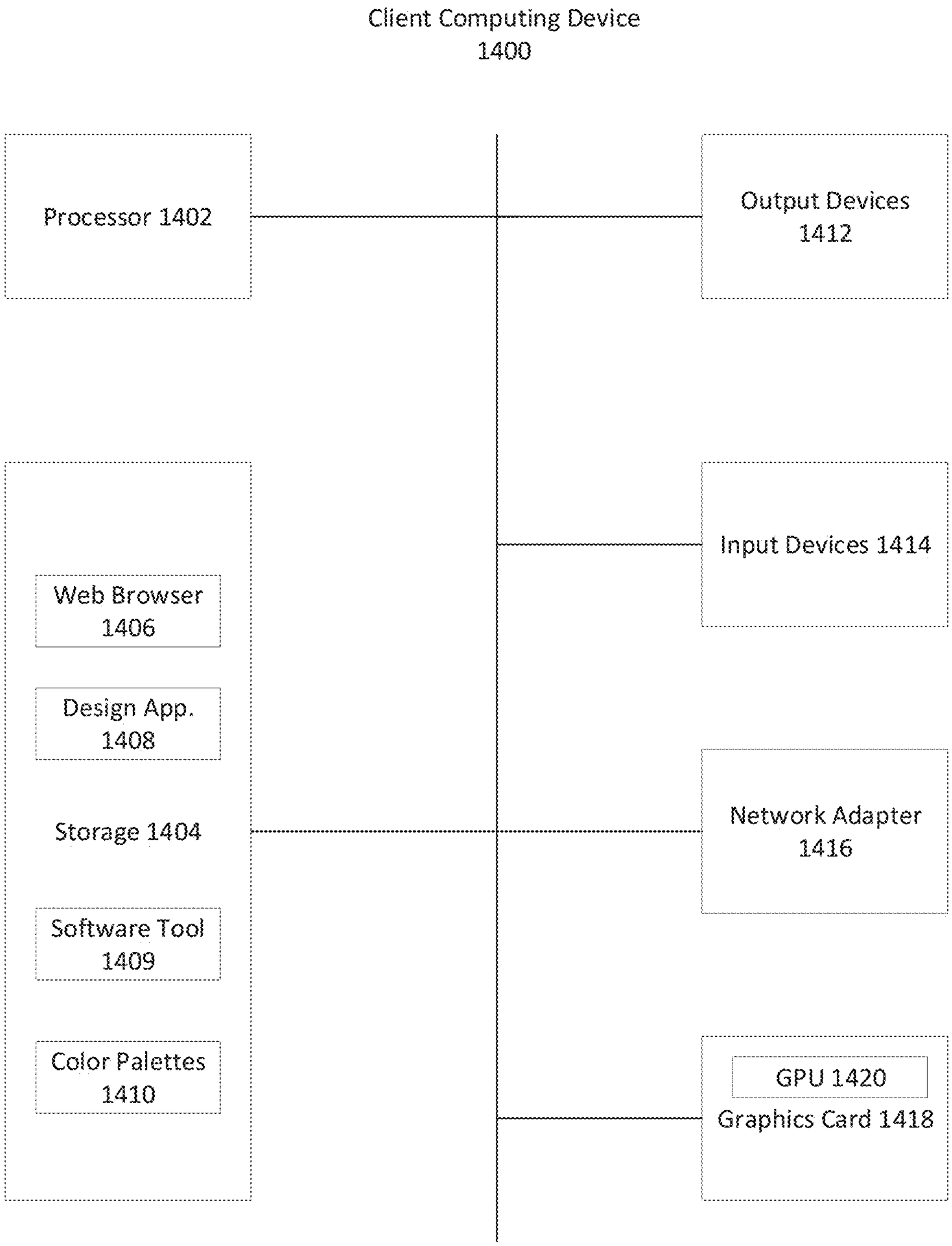

Client Computing Device
1400
Processor 1402
Output Devices
1412
Input Devices 1414
Web Browser
1406
Design App.
1408
Storage 1404
Network Adapter
1416
Software Tool
1409
Color Palettes
1410
GPU 1420
Graphics Card 1418

Figure 14

SOFTWARE TOOL FOR DERIVING COLORS FROM A REFERENCE COLOR BY VARYING COLOR CHARACTERISTICS

BACKGROUND

[0001] When a software designer develops a graphical user interface (GUI), the software designer needs to mindful of the colors that are deployed in the GUI. The software designer should adopt good design practices, such as maintaining a sufficient contrast ratio between colors positioned adjacent to each other on a display and avoiding using red on green or green on red because these color combinations are difficult for people with color blindness to view. These good design practices may be captured in accessibility guidelines and/or design guidelines.

[0002] Compliance with the accessibility and design guidelines may prove difficult for a software designer. A software designer typically resorts to using a manual trial-and-error approach when choosing colors and color combinations for a GUI. For instance, the designer may make a best guess for a desired color, enter the color code for the color on a computing device to display the color on a display device and review the resulting color on the display device. While the accessibility and design guidelines may set forth guidelines that suggest certain color characteristics like contrast ratios, relative luminance values and/or saturations for colors and color combinations, the accessibility and design guidelines may not set forth how to achieve such color characteristics. Moreover, often a software designer may not even know what the values of color characteristics such as saturation, relative luminance and contrast ratio are for colors. The result is that the process of choosing color combinations for a GUI may be time consuming and error prone. In addition, the software designer may not ever realize the desired color combinations for the GUI.

[0003] In developing a GUI, a software designer may wish to define and use a palette of colors that relate to a reference color and that conform with accessibility and/or design guidelines. For example, given a root brand color for an organization, the software designer may wish to use a palette of colors that relate to the root brand color. Unfortunately, the software designer must employ a manual trial-and-error approach to developing such a color palette. This manual trial-and-error approach can be burdensome on the software designer. This approach may be time consuming and may result in a sub-optimal color palette.

SUMMARY

[0004] In accordance with an inventive aspect, a method is performed by a processor of an electronic device. Per the method, a user interface is output for display on a display device. The user interface includes an element for specifying a first color value for a first color and one or more elements for specifying a change in saturation, relative luminance and/or contrast ratio to be applied to the first color value to yield a desired color value for a desired color. Per the method, a specification of a change of at least two of saturation, relative luminance or contrast ratio are received via the user interface. The change of at least two of saturation, relative luminance or contrast ratio to the first color value with the processor is applied by the processor to yield the desired color value. An indication of the desired color value is output on the display device.

[0005] The outputting on the display device of an indication of the desired color value may include outputting the desired color on the display device. The first color may be displayed on the display device. The receiving via the user interface of a specification of a change of at least two of saturation, relative luminance or contrast ratio may comprise receiving a specification of a change in saturation and relative luminance or receiving a specification of a change in contrast ratio and saturation. The one or more elements for specifying a change in saturation, relative luminance and contrast ratio to be applied to the first color value to yield a desired color value may include an element for specifying a programmatically determined maximum saturation, a programmatically determined minimum saturation, a custom saturation or a same saturation as the first color. The one or more elements for specifying a change in saturation, relative luminance and contrast ratio to be applied to the first color value to yield a desired color value may include an element for specifying a programmatically determined maximum relative luminance, a programmatically determined minimum relative luminance, a custom relative luminance or a same relative luminance as the first color.

[0006] In accordance with another inventive aspect, a method is performed by a processor of an electronic device. The method includes outputting a user interface for display on a display device. The user interface includes an element for specifying a first color value for a first color and an element for specifying at least one desired characteristic of an unspecified desired color relative to the first color. The at least one desired characteristic is one of a same RGB ratio as the first color but with a different specified relative luminance than the first color, a same RGB ratio as the first color with a specified contrast ratio separation from the first color, and a different RGB ratio than the first color with a same relative luminance as the first color. A specification of the first color value is received via the user interface. A selection of the at least one desired characteristic is received via the user interface. Based on the received specification of the first color value and the selection of the at least one desired characteristic, the processor determines what color is the desired color that has the selected desired characteristic relative to the first color. An indication of the desired color is output on the user interface.

[0007] The first color value may be a red, green, blue (RGB) value. The indication of the desired color may be a RGB value for the desired color. The method may include outputting on the display device as part of the user interface an example of the first color having the first color value and an example of the desired color.

[0008] The at least one desired characteristic may be having the same RGB ratio as the first color but with a different specified relative luminance than the first color. In that case, the method may further comprise displaying an element on the user interface for receiving a specification of the different relative luminance, receiving the specification of the different relative luminance via the user interface, and determining a selected color that the same RGB ratio as the first color but with the different specified relative luminance than the first color. In that case, the selected color may be determined to be the desired color.

[0009] The at least one desired characteristic may be having the same RGB ratio as the first color with the specified contrast ratio separation from the first color. In that case, the method may further comprise displaying an ele-

ment on the user interface for receiving a specification of the contrast ratio separation, receiving the specification of the contrast ratio separation via the user interface, and determining a selected color that has the same RGB ratio as the first color but has the specified contrast ratio separation from the first color. In that case, the selected color may be determined to be the desired color.

[0010] The at least one desired characteristic may be having a different RGB ratio than the first color with the same relative luminance as the first color. In that case, the method may further comprise displaying an element on the user interface for receiving a specification of the different RGB ratio, receiving the specification of the different RGB ratio via the user interface, and determining a selected color that has a different RGB ratio than the first color with the same relative luminance as the first color. In that case, the selected color may be determined to be the desired color.

[0011] In accordance with an additional inventive aspect, a method is performed by a processor of an electronic device. Per the method, an indication of a reference color value for a reference color is received. With the processor, a palette standard is applied to generate a palette of colors for use with the reference color in user interface design. The palette standard specifies how to derive colors to be included in the generated palette of colors from the reference color by modifying saturation, relative luminance and/or contrast ratio of the reference color.

[0012] The generated palette of colors may be partitioned into partitions that include a partition of colors designated for text. The generated palette of colors may be partitioned into partitions that include a partition of colors designated for control elements. The generated palette of colors may be partitioned into partitions that include a partition of colors designated for background use. The palette of colors may be for a particular lighting condition

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1**A depicts an illustrative user interface for exemplary embodiments before a first color operation has been selected.

[0014] FIG. **1**B depicts the illustrative user interface for the exemplary embodiments with the drop-down list for the first color operation expanded.

[0015] FIG. **2**A depicts the illustrative user interface for the exemplary embodiments with the drop-down list for relative luminance operations expanded.

[0016] FIG. **2**B depicts the illustrative user interface for the exemplary embodiments where the user has chosen to apply the maximum permissible saturation and the maximum permissible relative luminance to derive the desired color.

[0017] FIG. **3** depicts the illustrative user interface for the exemplary embodiments where the user has selected the operation of holding the relative luminance the same as the target color and where the saturation operation list is expanded.

[0018] FIG. **4** depicts a flowchart of illustrative steps that may be performed to derive a desired color by changing color characteristics of a target color in exemplary embodiment.

[0019] FIG. **5** depicts the illustrative user interface for an exemplary embodiment where the user has selected to enter a relative luminance value for the desired color.

[0020] FIG. **6** depicts the illustrative user interface for an exemplary embodiment where the user has specified a contrast ratio separation of the desired color relative to a secondary color.

[0021] FIG. **7** depicts the illustrative user interface for an exemplary embodiment where the user specifies a contrast ratio separation of the desired color relative to the target color.

[0022] FIG. **8** depicts the illustrative user interface for the exemplary embodiments where the user chooses to have the desired color have the relative luminance of the target color and the minimum saturation.

[0023] FIG. **9** depicts the illustrative user interface for the exemplary embodiments where the user chooses to have the desired color have a relative luminance that matches that of a secondary color and have the saturation of the target color.

[0024] FIG. **10** depicts an illustrative color palette.

[0025] FIG. **11**A depicts a flowchart of illustrative steps that may be performed in the exemplary embodiments to generate a color palette.

[0026] FIG. **11**B depicts illustrative color palettes for different lighting conditions.

[0027] FIG. **12** depicts a computing environment suitable for practicing the exemplary embodiments.

[0028] FIG. **13** depicts illustrative components of a server computing device or cluster.

[0029] FIG. **14** depicts illustrative components for a client computing device.

DETAILED DESCRIPTION

[0030] The exemplary embodiments may address the above-described shortcomings of the conventional approach for selecting colors to be included in a GUI. Such color selection by a software designer often entails determining what colors are suitable to be used together in a GUI, and then selecting for use in the GUI a subset of colors from the colors that are determined to be suitable for use in the GUI. The exemplary embodiments provide a software tool that enables a software designer to derive a color from a reference color. The software designer may specify changes in color characteristics, such as saturation, relative luminance and contrast ratio, that are to be applied to the reference color to derive the desired color. A user interface may be provided to allow the software designer to enter information regarding the reference color and the desired changes in color characteristics. The user interface may display the reference color and that resulting desired color so that the software designer may get a visual appreciation for the difference in the colors.

[0031] The software tool enables the software designer to select colors that are related to the reference color and that exhibit desired color characteristics relative to the reference color. The software tool enables color discovery and helps a software designer to better appreciate how changes in color characteristics, such as saturation, relative luminance, and contrast ratio, affect the resulting derive color.

[0032] The software tool of the exemplary embodiments may also include a color palette generator. The color palette generator may generate a palette of colors from a reference color. This may be especially useful in instances where a reference color, such as a root branding color for an organization like a corporation, is to serve as a foundation for the color palette that is deployed in a GUI. In the exemplary embodiments, a color palette standard may be created, and

the software tool may apply a color palette standard to derive the colors of a color palette from the reference color. The color palette standard may specify how the colors in the resulting color palette are to be derived relative to the reference color. For example, the color palette standard may specify that background colors are to have a certain saturation difference relative to the reference color and are to have a certain contrast ratio separation relative to the reference color. The ability to generate such color palettes from a reference color greatly simplifies the task for a software designer in developing a GUI in many instances. Moreover, the software designer may be assured that the resulting colors conform with accessibility guidelines and good design practices.

[0033] FIG. **1**A depicts an illustrative GUI **100** that may be generated by the software tool in exemplary embodiments. The GUI **100** includes a text box **110** in which a color value for a target color may be entered. In this illustrative case, the text box **110** accepts a RGB value specified in hexadecimal. In the hexadecimal encoding, the first two hexadecimal positions specify the red level of the color, the second two hexadecimal positions specify the green level of the color, and the final two hexadecimal positions specify the blue level of the target color. Thus, each primary color (red, green or blue) may have one of 256 different level values (ranging from 0 to 255) specified by the hexadecimal color value for the encoded color. The value of "0033A0" specifies a blue color value. The GUI **100** also includes a drop-down list box **120**. The drop-down list box **120** includes a drop-down list of first color operations that may be performed on the target color represented by the color value in text box **110**. A button **130** labeled as "=" may be selected to display information regarding both the target color associated with the color value in text box **110** and the resulting derived color value that results from applying color operations, as will be described in more detail below.

[0034] FIG. **1**B shows the GUI **100** when the drop-down list box **120** has been selected to be expanded. The drop-down list box **120** list operations that may be applied to the color represented by the target color value in the text box **110** in deriving a desired color. The drop-down list box **120** includes a prompt **130** to select a color operation.

[0035] Options **135**, **140**, **145**, **150**, **155**, and **160** relate to adjusting the saturation value of the target color to derive the desired color. Color saturation (hereinafter "saturation") refers to the intensity of color in an image. As saturation increases for colors, the colors appears more pure. As saturation decreases for colors, the colors appear to be more washed-out or pale. Saturation is how grey or not grey a color appears to the human eye. The list of possible color operations includes an option **135** to automatically select the saturation value in accordance with a gradient from black to white using a monochromatic path based on the RGB ratio of the target color. The RGB ratio is the ratio among the hexadecimal red, green and blue values within a hexadecimal representation of a color. The RGB ratio stays constant regardless of changes in relative luminance and saturation.

[0036] The list of possible color operations also includes an option **140** to apply a programmatically determined maximum saturation value at the relative luminance of the RGB ratio of the target color. Option **145** automatically applies a programmatically determined minimum saturation value at the relative luminance of the RGB ratio of the target color. Option **150** holds the saturation value at that of the target color. Option **155** prompts the user to enter a saturation value that is applied to the target color. Option **160** prompts the user to enter a hexadecimal color value and then set the saturation value to match the saturation value of the color associated with the entered hexadecimal value.

[0037] Options **165**, **170**, **175**, **180**, and **185** all relate to applying a change in relative luminance. Relative luminance refers to the relative brightness of any point in a color space and can be thought of as how bright a color appears to the human eye. Relative luminance may be normalized to have a value between zero, which indicates a darkest brightness, and one, which indicates a greatest brightness. Option **165** selects the highest (i.e., brightest) relative luminance value for the RGB ratio at the saturation level for the target color. Option **170** selects the lowest (i.e., darkest) relative luminance value for the RGB ratio at the saturation level for the target color. Option **175** sets the relative luminance at the relative luminance value of the target color. Option **180** produces a prompt for the user to enter a relative luminance value that is to be applied to the target color in deriving the desired color. Option **185** prompts the user to enter a second hexadecimal color value for a color and applies the relative luminance of the color represented by the secondary hexadecimal value to the target color in deriving the desired color.

[0038] Options **190** and **195** relate to applying the change in contrast ratio to the target color in order to derive the desired color. Option **190** prompts the user to enter a contrast ratio separation value relative to the target color. The contrast ratio separation may be in a range between −21 and 21. The entered contrast ratio separation is to be applied to the target color in deriving the desired color. Option **195** prompts the user to enter a hexadecimal color value and a contrast ratio separation value. Option **195** identifies a desired color that has the entered contrast ratio separation relative to the color represented by the entered hexadecimal color value.

[0039] In addition to displaying the drop-down list box **120** to select a first color operation, as shown in FIG. **2**A, the GUI **200** may also automatically generate and display a secondary list box **230** for selecting a second change operation that is to be applied to the target color. In the example depicted in FIG. **2**A, the secondary list box **230** prompts the user to select a relative luminance operation. Option **242** applies a maximum relative luminance value to the target color in deriving the desired color given the selected saturation and RGB ratio of the target color. Option **244** applies the minimum relative luminance value given the selected saturation and the RGB ratio of the target color. Option **246** holds the relative luminance value to that of the target color. Option **248** prompts the user to enter a relative luminance value that is to be applied to the target color to derive the desired color. Option **250** prompts the user to enter a secondary hexadecimal color value for a color. The relative luminance for the derived color is selected to match the color represented by the entered secondary hexadecimal value. Option **252** prompts the user for a contrast ratio separation from that of the target color and sets the contrast ratio for the derived color to that of a color that is separated by the specified contrast ratio separation from the target color. The contrast ratio specifies the relationship between the relative luminance of two different colors. Option **254** prompts the user to enter a hexadecimal color value for a secondary color, prompts the user for a contrast ratio separation from

that of the secondary color and sets the contrast ratio for the derived color to that of a color that is separated by the specified contrast ratio separation from the secondary color.

[0040] Thus, from the above discussion, it is apparent that the software tool enables multiple color characteristics of the target color to be changed to derive the desired color. For example, as shown in FIG. **2**A, the saturation and their relative luminance of the target color may be changed to derive the desired color. Alternatively, in some instances, only a single color characteristic of the target color may be changed to derive the desired color.

[0041] FIG. **2**B shows an example of the user interface **200** when the secondary drop-down list box **230** selects the secondary operation to be applying the maximum possible relative luminance to derive the derived color and button **260** is activated by selection. The GUI **200** now displays the hexadecimal code for the target color in text box **210**, the selection of applying the maximum saturation possible in drop-down list **220**, and the selection of applying the maximum relative luminance in drop-down list **230**. The GUI **200** updates when button **260** is selected to show the target color **265** and the derived color **275**. The display of the target color **265** and the derived color **275** in close proximity to each other helps the user to compare and contrast these colors **265** and **275**. In addition, the GUI **200** displays information **270** regarding the target color. This information **270** specifies the hexadecimal encoding of the color value for the target color, the saturation value for the target color and the relative luminance value for the target color. Similarly, information **280** is displayed regarding the desired color **275**. The information **280** includes the hexadecimal encoding for the desired color, the saturation value for the desired color, and the relative luminance for the desired color. In addition, the information **280** displays the contrast ratio of the desired color relative to the target color. The information **280** is useful to the user to understand the resulting saturation level, relative luminance and contrast ratio relative to the target color for the derived color. The information **280** also is useful in that it includes the hexadecimal color code for the derived desired color.

[0042] In some instances, as shown in FIG. **3**, the GUI **300** may display a secondary drop-down list box **306** relating to saturation operations. In GUI **300**, text box **302** displays a hexadecimal color code for the target color. Drop-down list box **304** indicates that the user selected to hold the relative luminance for the derived color at the relative luminance of the target color. A secondary drop-down list box **306** is displayed and includes a list **308** of saturation operations that may be applied to the target color in deriving the desired color. The options in the list **308** include option **310** of setting the saturation value at the maximum permissible saturation value given the selected relative luminance and RGB ratio of the target color. Option **312** sets the saturation value for the derived color at the minimum permissible saturation value given the selected relative luminance and RGB ratio of the target color. Option **314** sets the saturation value for the derived color as that of the target color. Option **316** prompts the user to enter a saturation value. Option **318** prompts the user to enter a secondary hexadecimal color code and sets the saturation value as that of the secondary color encoded by the secondary hexadecimal color code.

[0043] As was mentioned above, the GUI provided by the software tool in the exemplary embodiments may allow a user to produce a desired color from a target color by applying multiple color characteristics changes to the target color. FIG. **4** depicts a flowchart **400** of illustrative steps that may be performed in exemplary embodiments to realize such a derivation of the desired color from the target color. At **402**, the user interface (i.e., GUI) is displayed on a display device. The user interface may take the form of that depicted above in FIGS. **1**A-**3**B or may take other forms. It should be appreciated the user interface may include different types of user interface elements and different organizations of those elements. Via the user interface, the software tool receives a specification of a first color value at **404**. For example, the user may enter a hexadecimal RGB color value in text box **110**. At **406**, the software tool then receives specification of changes in at least two of saturation, relative luminance, or contrast ratio that are to be applied in deriving the derived color from the target color. In some exemplary embodiments, these may be entered via the user interface, such as via drop-down list boxes **220** and **230**. At **408**, the software tool applies the specified changes to the color characteristics to yield the desired color value by applying the changes to the target color. The software tool possesses the requisite logic to perform the specified color characteristics changes. At **410**, an indication of the desired color value is output. FIG. **2**B shows an example where the desired color **275** is displayed along with information **280** that includes the color code for the desired color as well as color characteristics information for the desired color.

[0044] The software tool of the exemplary embodiments provides capabilities that are useful to the software designer in identifying colors to use in a GUI. One such capability is to choose a desired color with the same RGB ratio but a different relative luminance as illustrated in FIG. **5**. As shown, the user interface **500** includes a text box in which a hexadecimal code for a target color has been entered. The user has selected to enter a relative luminance value as evidenced by the drop-down list **512** showing "Enter RL." In addition, a text box **520** is shown. The user has entered a relative luminance value of 0.2 in the text box **520**. Drop-down list box **514** is displayed for the user to select a saturation value, but the user has chosen to not enter a saturation value. The user has selected the button **524** so that the target color **530** and the desired color **540** are displayed. Information **535** about the target color and information **545** about the desired color are displayed. As can be seen, the target color **530** and the desired color are both blue (i.e., have same RGB ratio) but differ as to relative luminance. The desired color **540** has a relative luminance of 0.2, and the target color has a relative luminance 0.049.

[0045] Another useful capability provided by the software tool is to enable a user to enter a contrast ratio value as well as a secondary hex value whose relative luminance the user wants to move away from. For example, suppose that a user wishes to find a yellow that has a contrast ratio that is three times brighter than a shade of blue. The user may enter a hexadecimal code for the yellow as the target color, the contrast ratio of 3 and the hexadecimal code of color the user wished to move away from in a secondary hexadecimal text box.

[0046] FIG. **6** depicts a user interface **600** for this capability. The user interface **600** includes a text box **605** in which a hexadecimal color code value has been entered for a target color. The user has selected the operation of choosing a specified contrast ratio separation based upon a secondary hexadecimal value as indicated by the selection from

drop-down list box **610**. A contrast ratio value of 1.1 has been entered in text box **615**, and a secondary hexadecimal value has been entered in text box **620**. The button **630** has been selected so that target color **635** and associated information **640** are displayed, as is the desired color **645** and associated information **650**.

[0047] An additional capability provided by the software tool is to identify a color that has a contrast ratio separation from a color, such as a target color. FIG. **7** depicts an illustrative user interface **700** for illustrating this capability. The user interface **700** has a text box **710** in which a hexadecimal color code for a target color has been entered. The user has selected the operation of the specifying a contrast ratio from the target color in the drop-down list **715**. The user has entered a 1.8 contrast ratio separation value in text box **725**. A drop-down list **720** is displayed to give the user an option to select a saturation operation, but the user has chosen not to not select such a saturation operation. The user has selected button **730**. The target color **735** is shown along with information **740** about the target color **735**. The desired color **745** is shown along with information **750** about the desired color. As is shown, the desired color **745** has a contrast ratio of 1.798 or roughly 1.8 relative to the target color **735**.

[0048] An additional capability of the software tool is to find a color that has a same relative luminance as a target code but a different saturation. FIG. **8** illustrates an example user interface **800** that may be provided by the software tool in realizing this operation. The user interface **800** includes a text box in which the user has entered the hexadecimal code for the target color. Drop-down list box **810** shows that the user has selected the first operation of holding the relative luminance of the desired color to be the same as the target color. A second drop-down box **815** is displayed. The user has selected the saturation operation of changing the saturation for the desired color to the minimum permitted saturation. Button **820** has been selected by the user, so the target color **825** and associated information **830** are displayed. The desired color **835** and associated information **840** are displayed. As can be seen, the saturation of the target color and the desired color are different. The target color has a saturation of 0.627, whereas the desired color has a saturation of 0. In addition, the relative luminance of the target color of 0.049 is roughly equal to the relative luminance of the desired color of 0.05.

[0049] A further capability provided by the software tool is the capability to have the derived color match the relative luminance of a secondary color that the user may enter. FIG. **9** depicts an illustrative user interface **900** for such a case. A hexadecimal color code value for a target color has been entered by the user in text box **905**. The user has chosen the operation of matching the relative luminance to a secondary color in drop-down list box **910**. A secondary hexadecimal color code has been entered in text box **915** by the user. The saturation level has been held to match the target color saturation as evidenced by the selection in drop-down list **920**. Button **925** has been selected. The target color **930** and associated information **935** are displayed. The desired color **940** and the associated information **945** are displayed. The relative luminance value (0.078) of the desired color matches that of the secondary color with the color code 1111FF.

[0050] The software tool of the exemplary embodiments may generate color palettes for use by a software designer in generating a GUI. FIG. **10** displays an illustrative color palette. FIG. **10** depicts categories of colors that may be found in the illustrative color palette **1000**. The color palette **1000** may include background colors **1002** that are suitable for use in the background of the GUI. The color palette **1000** may also include control/content level colors **1004** for use in controls in the GUI or content in the GUI. The color palette **1000** may include text colors **1006** for coloring text in the GUI. The color palette **1000** may include data visualization colors **1008** for color data visualizations, like graphs or charts. The colors in each category are selected to be well suited for the designated use. Suppose that the software designer needs to color the background of the GUI, the software designer only needs to search the colors in the background colors **1002**. The software designer can be confident that the colors in the background colors **1002** are well-suited for such use.

[0051] FIG. **11**A depicts a flowchart **1100** of illustrative steps that may be performed in exemplary embodiments to produce a color palette. First, at **1102**, the software designer identifies a root color. The other colors in the color palette relate to the root color. The root color may be, for instance, a brand color associated with an organization, such as a company. At **1104**, a palette standard in then selected by the software designer. There may be different palette standards available for selection. Each palette standard encodes how to generate the colors in the color palette from the root color. Each palette standard may be the result of determining how the root color deviates from a pure form of the color across color channels, saturation, and relative luminance and applying the determined deviations to a different color. Consider a simple palette having just a red value, a green value and a blue value. The root value is a reference blue color represented by a hexadecimal value (e.g., #0033A0). This color has a deviation from pure blue (e.g., a hexadecimal value of #0000FF) in saturation. Specifically, the root color represented by #0033A0 has a saturation of roughly 63% of full saturation. The root color also deviates in relative luminance and in relative amounts of red, green and blue from pure blue. These deviations are determined and applied to the other colors for a palette to yield a red color and a green color for the palette. A red value of #A03300 may be chosen that matches the determined deviation in saturation and relative luminance with the blue color represented by #0033A0. The red value has a similar amount of green as the reference blue color (i.e., #33). A green value of #33A000 may be chosen based on the deviations and relative amounts of red, green and blue. This process may be extended to the full color palette where additional colors are needed.

[0052] At **1106**, the selected color palette standard is then applied to generate the desired color palette. Each category of color as detailed in FIG. **10** may have its own rules as to relative luminance and saturation. These rules may be applied to generate colors for the category relative to the reference color. This approach mimics the disposition of the relative amounts of red, green and blue, saturation, and relative luminance from the reference color(s), while assuring the integrity of color use for functional applications. The software tool does this by performing calculations, rather than relying on designers to do this "by eye."

[0053] Different color palettes may be generated for different lighting conditions from a baseline color palette. FIG. **11**B depicts an example set of color palettes for different lighting conditions. The contrast ratios for colors in the

palettes may change depending on lighting conditions. There is a low lighting color palette **1120** for use in low lit environment, such as a darkened room. There is a medium lighting color palette **1122** for normal well-lit environments and a bright lighting color palette **1124** for brightly lit environments.

[0054] FIG. **12** depicts a computing environment **1200** suitable for practicing the exemplary embodiments. A client computing device **1204** may be provided for a user to access the software tool. The client computing device **1204** may be a desktop computer, a laptop computer, a tablet computer or another variety of computing device. In some embodiments, the client computing device **1204** may be an embedded system in an electronic device. The client computing device **1204** has a display device **1202** for displaying graphical content, text and/or video. In some embodiments, the software tool may be run locally on the client computing device **1204**. In other embodiments, the software tool may run on a server computing device or a cluster **1208** that is connected to the client computing device via a network **1206**. The server computing device or cluster **1208** may be a cloud service in some instances. The server computing device or cluster **1208** may host a website that is accessible to the client computing device over the Internet via a web browser in some embodiments. The network **1206** may include one or more local area networks (LANs) and wide area networks (WANs) such as the Internet or the like.

[0055] FIG. **13** depicts illustrative components for the server computing device of cluster **1300**. One or more processors **1302** may be provided for executing computer programming instructions. The processor(s) **1302** may include a central processing unit (CPU), a graphics processing unit (GPU), a field gate programmable array (FPGA) or an application specific integrated circuit. The server computing device or cluster **1300** may include a storage **1304** for storing computer programming instructions for execution by the processor(s) **1302**, data and other items. The storage **1304** may include primary memory and secondary memory. The storage **1304** may include a variety of non-transitory computer-readable storage media, including random access memory (RAM), read only memory (ROM), solid state memory, magnetic storage media, optical storage media or the like. The storage may store a design application **1306** that may be executed to provide GUI design capabilities to the user. The software tool **1308** may be stored in the storage **1304** described herein. The user may access the software tool as a service and may be realized as a web application. The software tool **1308** may be integrated into the design application in some instances. The storage may also store color palette standards **1310** and color palettes **1312**. The server computing device or cluster **1300** additionally may include output devices **1312**, like a display, input devices **1314**, like a keyboard or mouse. A network adapter **1316** for interfacing with a network.

[0056] FIG. **14** depicts illustrative components for the client computing device **1400**. The client computing device **1402** may include a processor **1402**. The processor may be a CPU, GPU, ASIC or the like. The processor has access to a storage **1404**. The storage **1404** may include a variety of non-transitory computer-readable storage media, including random access memory (RAM), read only memory (ROM), solid state memory, magnetic storage media, optical storage media or the like. The storage **1404** may store a web browser **140**, a design application **1408** for designing a GUI and the software tool **1409** for execution by the processor. In some embodiments, the software tool **1409** and the design application **1408** may not be present but rather may be run on the server computing device or cluster. Color palettes **1410** may be stored in the storage **1404** for use in designing GUIs. The client computing device **1400** may include output devices **1412**, like a display device or printer. The client computing device **1400** may include input devices **1414**, like a keyboard, mouse, thumbpad or microphone. The client computing device **1400** may include a network adapter **1416** for interfacing with the network **1206**. The client computing device **1400** may include a graphics card **1418** with a GPU for displaying content on a display device.

[0057] While exemplary embodiments have been described herein, various changes in form and detail may be made relative to the exemplary embodiments without departing from the intended scope of the claims appended hereto.

1. A method performed by a processor of an electronic device, comprising, via the processor:

outputting a user interface for display on a display device, wherein the user interface comprises:

an element configured to receive user input specifying a reference color, the reference color comprising a first single color; and

one or more elements for specifying a change in saturation, relative luminance and/or contrast ratio to be applied to the reference color to determine a desired color, the desired color comprising a second single color;

receiving via the user interface a specification of a change of at least two of saturation, relative luminance or contrast ratio;

applying the change of at least two of saturation, relative luminance or contrast ratio to the reference color inputted via the element to determine a desired color value of the desired color; and

outputting on the display device the desired color, as an individual second single color, beside the reference color, as an individual first single color.

2. The method of claim **1**, wherein the outputting on the display device of the desired color comprises outputting on the display device at least one of the saturation or relative luminance for the desired color.

3. The method of claim **1**, wherein the method further comprises outputting on the display device a hexadecimal encoding for the desired color.

4. The method of claim **1**, wherein the receiving via the user interface a specification of a change of at least two of saturation, relative luminance or contrast ratio comprises receiving a specification of a change in saturation and relative luminance.

5. The method of claim **1**, wherein the receiving via the user interface a specification of a change of at least two of saturation, relative luminance or contrast ratio comprises receiving a specification of a change in contrast ratio and saturation.

6. The method of claim **1**, wherein the one or more elements for specifying a change in saturation, relative luminance and contrast ratio to be applied to the reference color to determine the desired color value of the desired color comprise an element for specifying a programmatically determined maximum saturation, a programmatically

determined minimum saturation, a custom saturation or a same saturation as the reference color.

7. The method of claim **1**, wherein the one or more elements for specifying a change in saturation, relative luminance and contrast ratio to be applied to the reference color to determine the desired color value of the desired color comprise an element for specifying a programmatically determined maximum relative luminance, a programmatically determined minimum relative luminance, a custom relative luminance or a same relative luminance as the reference color.

8. A method performed by a processor of an electronic device, comprising:

outputting a user interface for display on a display device, wherein the user interface comprises:

an element configured to receive user input specifying a first color value for a first color, the first color comprising a first single reference color;

an element for specifying at least one desired characteristic of an unspecified desired color relative to the first color, the desired color comprising a second single color, wherein the at least one desired characteristic is one of:

a same RGB ratio as the first color but with a different specified relative luminance than the first color,

a same RGB ratio as the first color with a specified contrast ratio separation from the first color, and

a different RGB ratio than the first color with a same relative luminance as the first color, and

receiving via the user interface a specification of the first color value;

receiving via the user interface a selection of the at least one desired characteristic;

based on the received specification of the first color value and the selection of the at least one desired characteristic, determining with the processor what color is the desired color that has the selected desired characteristic relative to the first color; and

outputting the desired color on the user interface, as an individual second single color, beside the reference color, as an individual first single reference color.

9. The method of claim **8**, wherein the first color value is a red, green, blue (RGB) value.

10. The method of claim **9**, wherein the indication of the desired color is a RGB value for the desired color.

11. The method of claim **8**, further comprising outputting on the display device as part of the user interface an example of the first color having the first color value and an example of the desired color.

12. The method of claim **8**, wherein the at least one desired characteristic is the same RGB ratio as the first color but with the different specified relative luminance than the first color, wherein the method further comprises:

displaying an element on the user interface for receiving a specification of the different relative luminance;

receiving the specification of the different relative luminance via the user interface; and

determining a selected color that the same RGB ratio as the first color but with the different specified relative luminance than the first color; and

wherein the selected color is determined to be the desired color.

13. The method of claim **8**, wherein the at least one desired characteristic is the same RGB ratio as the first color with the specified contrast ratio separation from the first color, wherein the method further comprises:

displaying an element on the user interface for receiving a specification of the contrast ratio separation;

receiving the specification of the contrast ratio separation via the user interface; and

determining a selected color that has the same RGB ratio as the first color but has the specified contrast ratio separation from the first color; and

wherein the selected color is determined to be the desired color.

14. The method of claim **8**, wherein the at least one desired characteristic is the different RGB ratio with the specified contrast ratio separation from the first color, wherein the method further comprises:

displaying an element on the user interface for receiving a specification of the different RGB ratio;

displaying an element on the user interface for receiving the contrast ratio separation;

receiving the specification of the different RGB ratio and the contrast ratio separation via the user interface; and

determining a selected color that has the different RGB ratio than the first color and has the specified contrast ratio separation; and

wherein the selected color is determined to be the desired color.

15. The method of claim **8**, wherein the first color value is a hexadecimal color value.

16. A method performed by a processor of an electronic device, comprising, via the processor:

receiving user input configuring a palette standard defining at least one difference in one of saturation, relative luminance and/or contrast ratio from a reference color for each of a plurality of graphical user interface (GUI) categories;

receiving user input specifying the reference color comprising a single color;

applying the palette standard to the reference color to generate a palette of colors for use with the reference color in user interface design, wherein the palette standard specifies how to derive colors to be included in the generated palette of colors from the reference color by modifying saturation, relative luminance and/or contrast ratio of the reference color, wherein the palette of colors comprises a plurality of colors derived from the reference color based on the palette standard; and

displaying the palette of colors partitioned into the plurality of GUI categories.

17. The method of claim **16**, wherein the plurality of GUI categories comprises a partition of colors designated for text.

18. The method of claim **16**, wherein the plurality of GUI categories comprises a partition of colors designated for control elements.

19. The method of claim **16**, wherein the plurality of GUI categories comprises a partition of colors designated for background use.

20. The method of claim **16**, wherein the palette of colors is for a particular lighting condition.

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